The improvement of the calibration of Muon detector

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Abstract

The object and the method of the calibration of muon detector is introduced in this report. The deficiencies of the old software calibration method are pointed out and the solution is provided. After the improvement, the Z resolution of the inner layer of the muon detector is improved from 7.9 cm to 5.6 cm. The constants produced by the new method are also checked by the new J/Ψ data.

Key word: calibration, muon detector, charge division

- **The object and the method of the calibration**
- **The problem and the solution**
- **The subroutines and the result**

1 The object and the method of the calibration

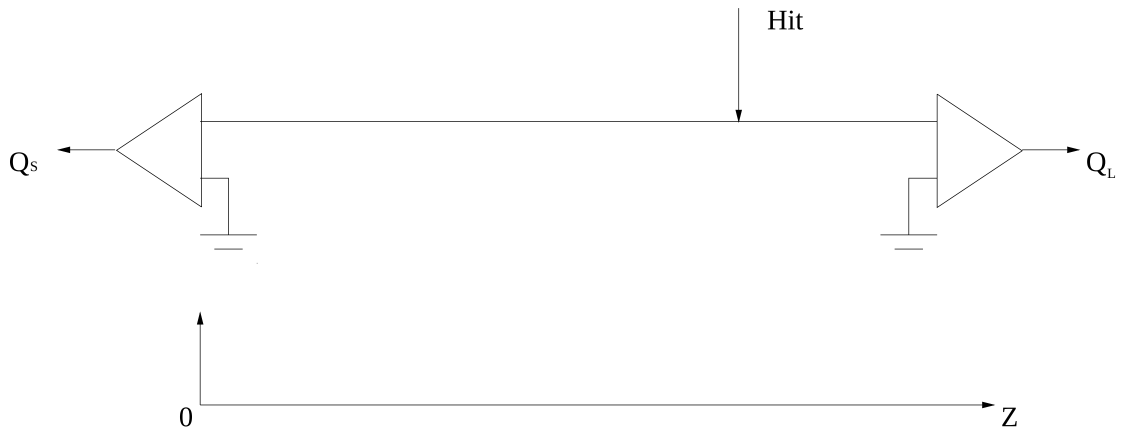
1.1 Object

The object of the calibration of Muon Detector is to produce the constants to decide the Z position. That is to say, the constants will be used in the track reconstruction of Muon Detector, converting the electronic impulse into the Z position.

1.2 Method

1.2.1 Charge division method

The schematic diagram of charge division method



The Z position is a linear function of $Q_L/(Q_L+Q_S)$

$Z = A\times Q_L/(Q_L+Q_S) + C$

if the enlargement factors of the two amplifiers have some difference, then B factor is needed.

$Z = A\times Q_L/(Q_L+B\times Q_S) + C$

Sample data ($Z;Q_L,Q_S$) are used to determinate the factor A, B, and C. Sample data are produce by some electronic instruments when we do the hardware calibration, while by selected dimuon events if we do the software calibration.

1.2.2 Software calibration method

Selection of dimuon events

The criteria of the dimuon selection are as follows,

* VC

Vertex position :$R_{xy} \leq 1.0$ cm , $Z \leq 20.0$ cm

* MDC

NCHRG = 2

MFIT = 2 or -19

$\sum$Qi = 0

1.348GeV $\leq$ P_μ $\leq$ 1.748GeV

The direction of the tracks : $\cos(\theta) \leq 0.6$

The inclination of the two tracks: $\cos(\theta) \leq$ -0.995

* BSC

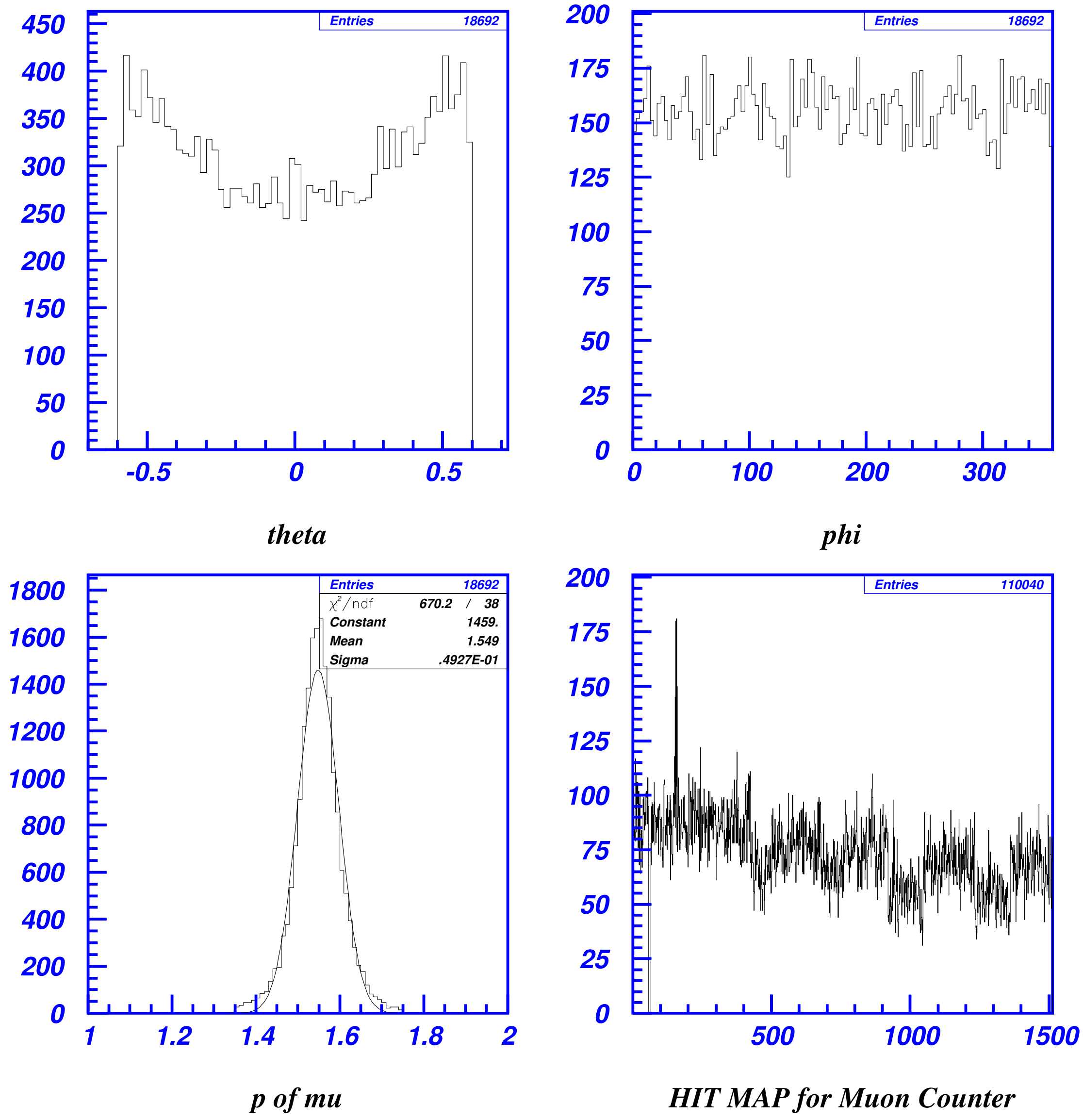
0.0GeV $\leq$ E_{BSC} $\leq$ 0.7GeV

* TOF

0.0 $\leq$ TOF $\leq$ 7.0 ns

ΔTOF $\leq$ 4.0 ns

The distribution of the θ, ϕ, momenta and hitmap of the selected dimuon events is as follows,



1.2.3 The old software calibration method

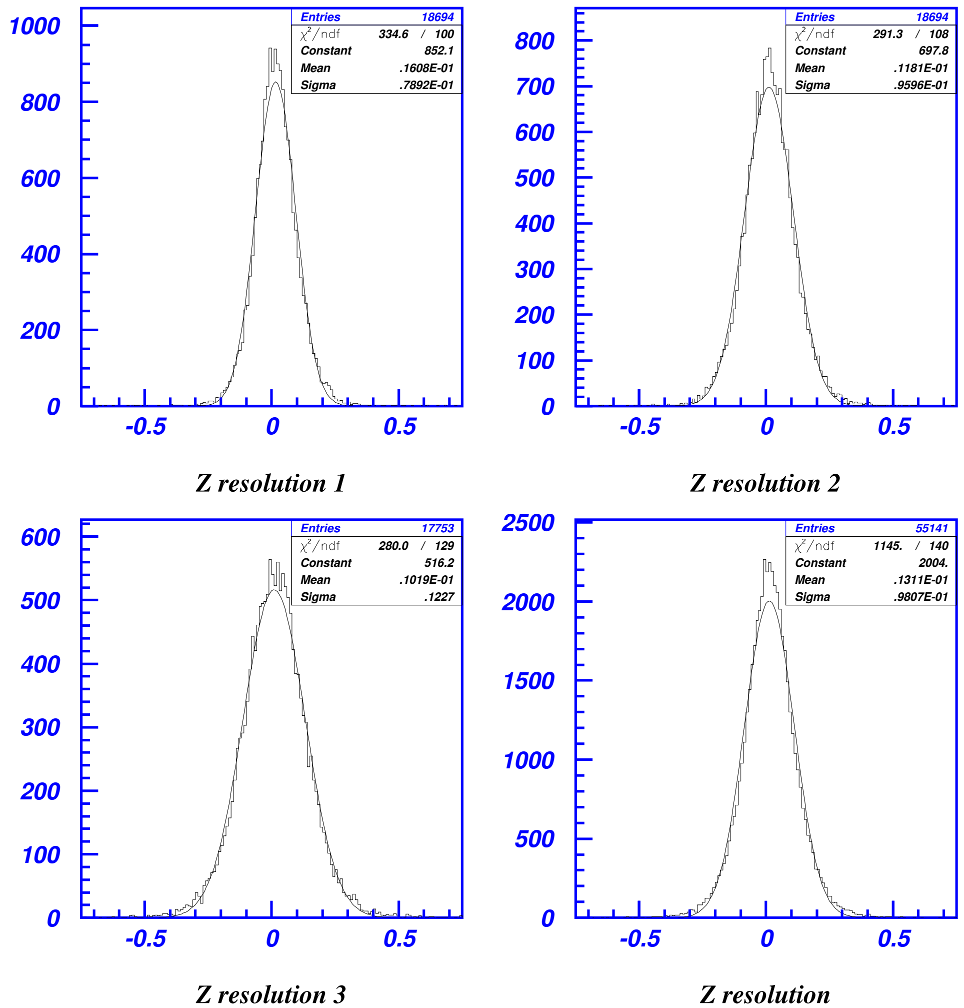
The A and C constants will be produced through this method, while the B constants is just copied from the result of hardware calibration. Since Z is a linear function of $Q_L/(Q_L+Q_S)$, it can be called linear fitting. The library subroutine LFITW is used to do fitting.

In an assemble of muon detector, two wires are connect together to reduce the output channels of signals. So they share one group parameters (A,B,C). When calibration, only the parameters of one wire are fitted out and these parameters are use for the other one.

2 The problem and the solution

2.1 Problem

The result from the old software calibration method is as follows,



Z resolution 1

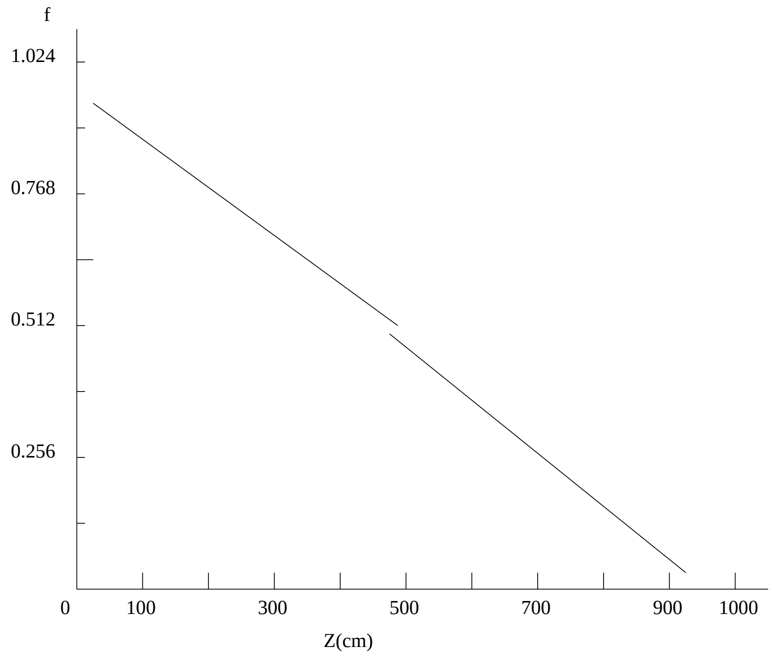
Z resolution 2

Z resolution 3

Z resolution

The Z resolution of the inner layer of the muon detector is about 7.9cm, but it is about 5.8cm if the constants from the hardware calibration are used. This means that there is some deficiencies in the old method of software calibration.

There are two possible causes of the deficiencies. First, the B constant is not correct. Since B constant is used to equalize the enlargement factors of these two amplifiers, it will change as the enlargement factors change. Since the hardware calibration was done several years ago, the factors must have changed, so the B constant from the result of the hardware calibration is not suitable now. Second, to let the two wire share one group of constants is too simplistic, because there is always some differences between two wires. More over the resistance of the connection point of the two wires is not zero, this does not accord with the principle of charge division method. The following figure shows this problem. f=$Q_L/(Q_L+Q_S)$

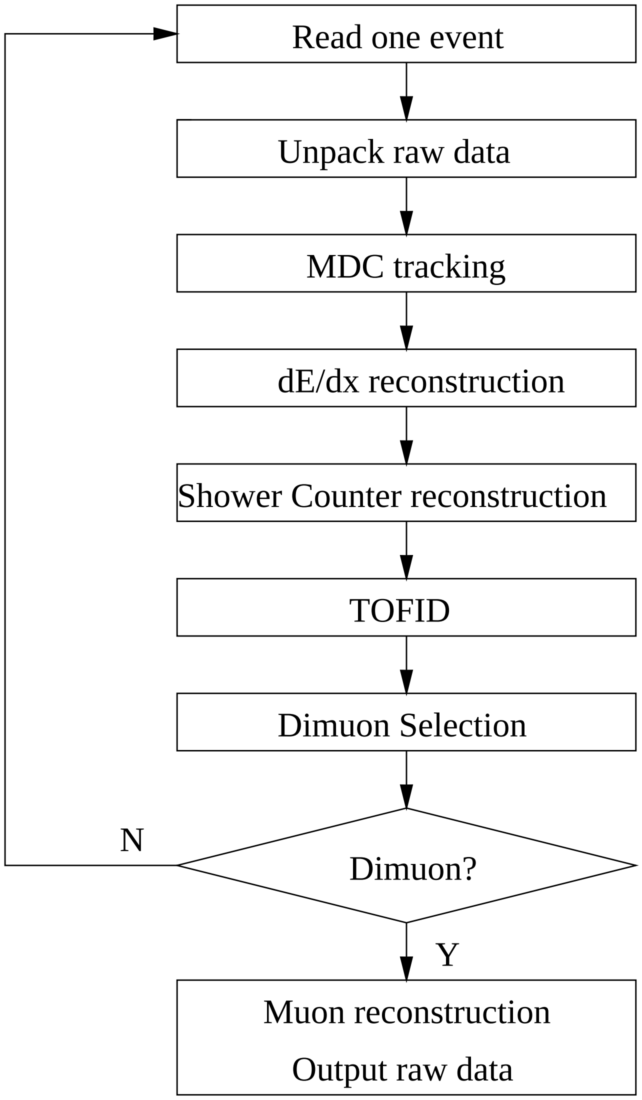


2.2 Solution

The solution is focused on the two causes above. We use five different constants (A1,C1,A2,C2,B) for each two conjoined wires. Here we do not use six constants (A1,C1,A2,C2,B1,B2), because that will change the reconstruction program. New B constants are produced in this solution. Since Z is not a linear function of $Q_L/(Q_L+Q_S)$, no-linear fitting method is used. We use a subroutine called DFUNFT, which is a library subroutine of CERN Program Library.

3 The subroutine and the result

The flow chart of the software calibration is as follows,



An include file 'mucal.inc' and some subroutines which are used for the calibration of muon detector have been added into the BES software Library V102, they are,

Subroutines (to be added to the BES Lib V102)

Dimuslct !select dimuon events at $2E_{beam}$

Dxxini !initialize dxx

Mucalini !inintalize ql and qs

Getadc !get Q_L and Q_S

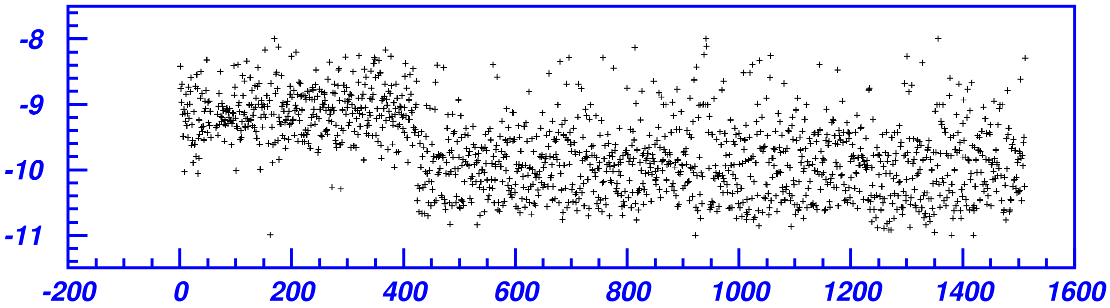
Muhitmap !output the hitmap

Saveadc !save all the data for the offline calibration

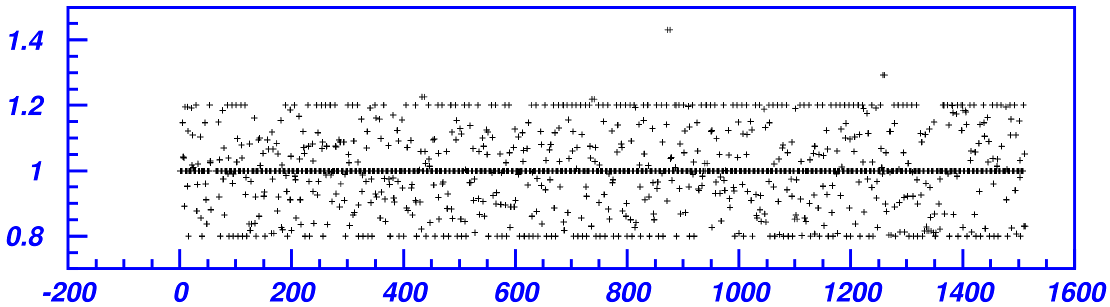
Mucalib !do fitting

Include file
mucal.inc !common block for the calibration

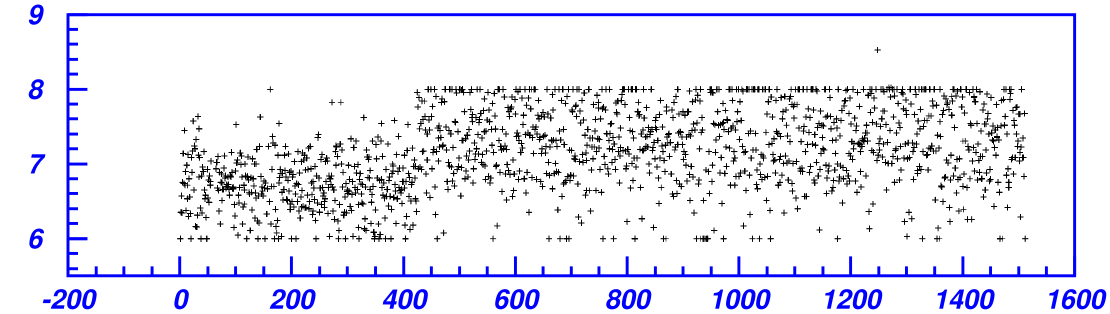
We used the dimuon event sample selected from the run13751 through run13800 on 3.097 GeV energy point to do the calibration. We gained a constant file called muz13800.offcons. The distribution of each parameter (A,B,C) is as follows.



a VS. iwire

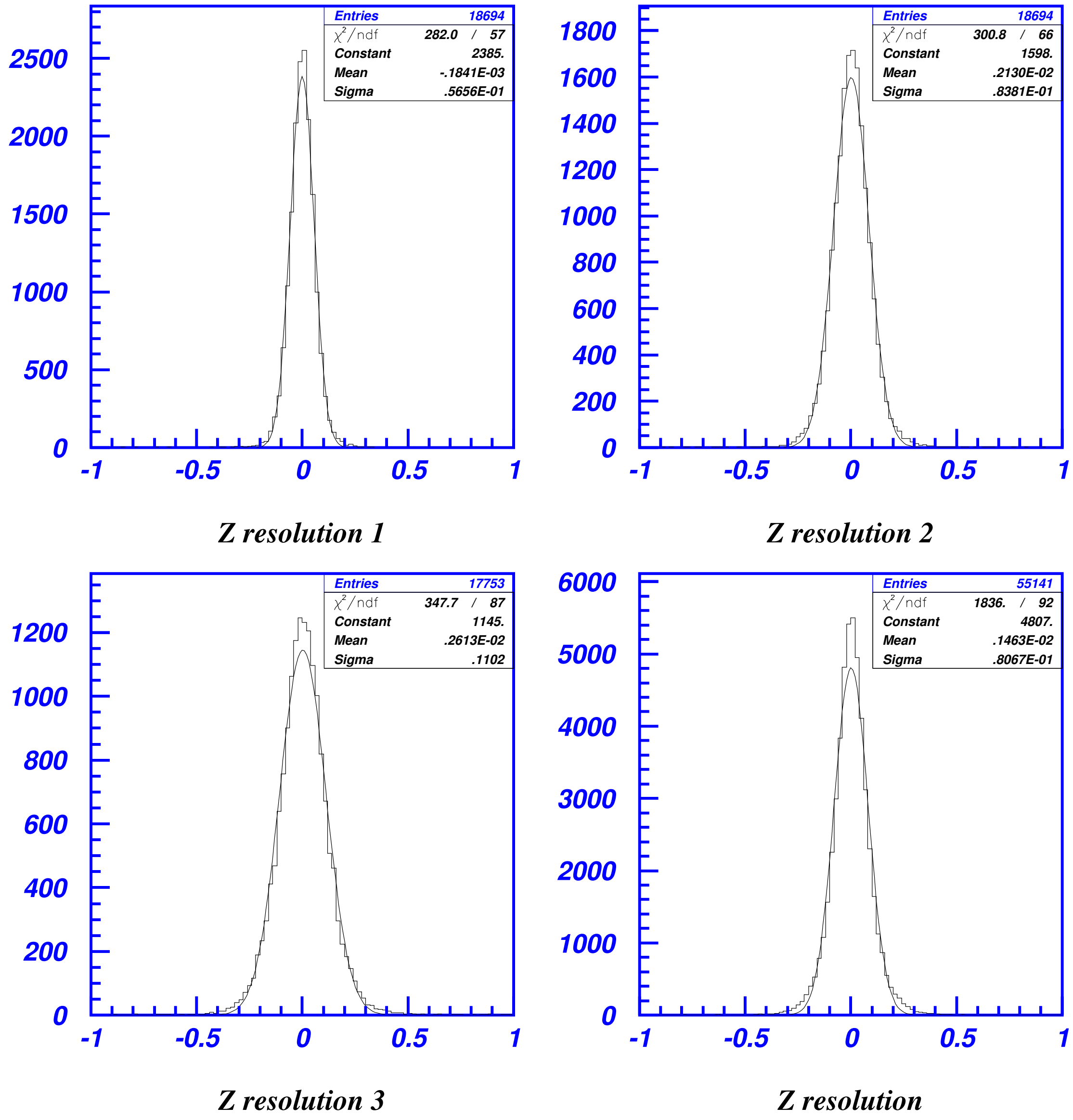


b VS. iwire

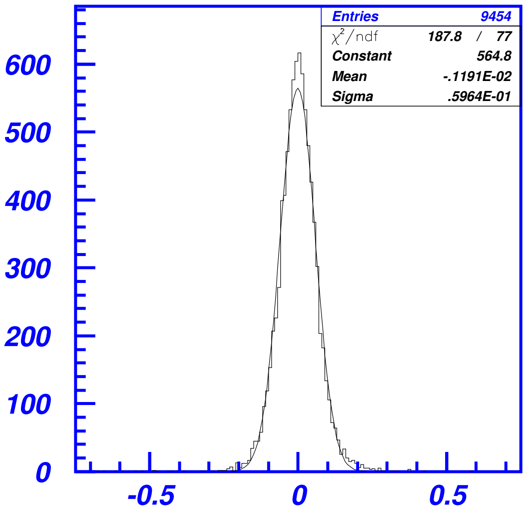


c VS. iwire

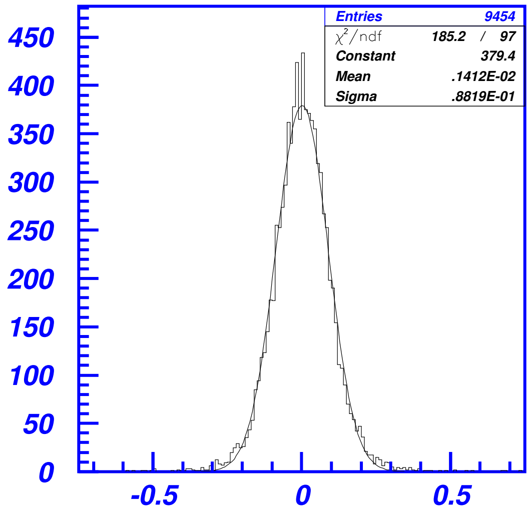
We use this sample to check the Z position resolution, the result is as follows,



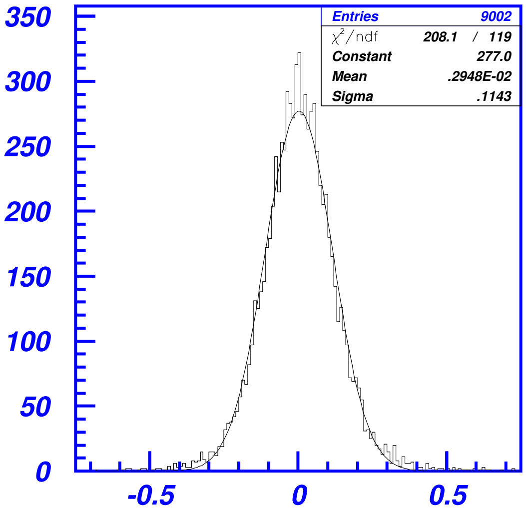
Another dimuon event sample selected from run14808 through run14850 is also used to check the Z position resolution using the constants of muz13800.offcons. The result is as follows,



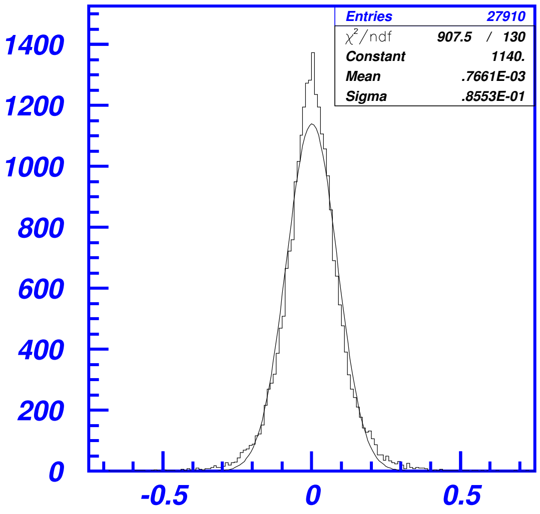
Z resolution 1



Z resolution 2



Z resolution 3



Z resolution

From the above two figures, we can conclude that

- The new method improves the resolution of Z position.
- The constants of muz13800.offcons can be used in the later data.